THE ELECTRO-OSTEOTOME.

A New Instrument for the Performance of the Operation of Osteotomy.

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Granting that surgeons, especially of late, have too frequently resorted to operative procedures for the relief of bony deformities ; that they have shown a disinclination to adopt the more judicious, safe, and rational treatment by means of suitably constructed orthopedic apparatus, there is nevertheless a large and diversified class of cases which can only be successfully dealt with by operative interference. Many patients suffering from bony deformities that would have been amenable to mechanical treatment in their early stages come under the observation of the surgeon too late in life to avoid an operation. Again, in general hospitals and ambulatory clinics, where we have to do even with young subjects, the expense of orthopedic apparatus and the necessarily long continuance of mechanical treatment to effect a cure, may deprive the patient of therapeutic measures which would be adopted in private practice, thereby relegating his destinies to the domain of osteotomies.

It therefore becomes the subject of legitimate inquiry as to the best means of performing these operations.

It is not the purpose of this communication, however, to review the various operations of Mayer, Annandale, Barton, Adams, Ogston, Barwell, Reeves, Macewen, and other surgeons; nor to discuss in detail the merits and demerits of the tools which have been used by operators other than myself. I wish simply to call attention to an instrument which, in my opinion, in a large range of cases possesses important advantages over any that have hitherto been employed. This conclusion has been reached after a sufficiently extended and varied personal experience from which to make deductions.

The instruments used by surgeons in the operation of osteotomy* may all be classified under the following heads:

1. Chisels.
2. Cutting forceps or nippers.
3. Shears.
4. Gimlets.
5. Drills.
6. Saws.

Of these instruments the saw possesses the superior qualities of rapidity, certainty, and evenness of cut. Furthermore, by its use the concussion and shock incident to the employment of the chisel and mallet, are entirely avoided. Why then do surgeons ever resort to the use of chisels, drills, etc.? The reasons are as follows:

First, as to the use of the long or straight saw. Though admirably adapted to the direct application of hand power, its to-and-fro movements render it hazardous to the soft parts under many circumstances. This objection, however, has been very successfully overcome in that form of the instrument devised by Dr. George F. Shrady, in which the blade is operated through a protecting metallic sheath. His saw is very narrow, and was especially designed for simple subcutaneous transverse section of bone. Another objection to the straight saw is the impossibility of executing to-and-fro movements in certain situations. Moreover, it is not well adapted to the removal of cuneiform segments from bone deeply imbedded in the soft parts. And, finally, it is, for the most part, impracticable to use it in making longitudinal cuts.

I pass in review the objections to the use of the hollow (trephine) and chain saws, which must be patent to all.

The circular saw, though equally well suited in form to the removal of transverse wedges of bone and the making of longitudinal cuts, and not open to the objection of to-and-fro movements, has never been extensively employed by surgeons. The reasons for its disuse lie, then, not in its form, nor in its rotary movement. Carrying our inquiry a little further, however, they become evident. Paramount among these is the impossibility of a direct application of hand-power to the

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* The word is here used in its broadest signification.

evolution of the rotary motion of the circular saw. If manual power be used at all, some mechanism is necessary in order to develop rotation of the blade.

Two difficulties present themselves in the adaptation of hand-power to driving the circular saw. One of these is the disadvantage with which force is applied at the axis of motion to overcome resistance at the peripheral margin. The other is the rapidity of rotation necessary to effective work. If the problem were the construction of a hand machine to rotate a circular blade meeting with no resistance at its periphery, nothing would be more simple. Or, if power could be applied at the margin of the blade to overcome resistance at the axis of motion, the device of such a machine would still be a very simple mechanical problem. It is, then, the great resistance which the serrated edge meets when in contact with bone, and the necessity of overcoming this by power applied to the arbor of the blade that make the task of construction and propulsion so difficult.

A number of ingenious inventions have been offered, but when put to the test of sawing bone on the living subject have not answered in practice what they promised in speculation. As a rule their blades have been placed at a right angle with the main shaft, and, on this account, have been difficult to hold in position. They have, without exception, been deficient in power or speed, or both. Of the hand and foot-motors which have been devised for driving circular saws, that which is ordinarily used for dental purposes is the most complete in its workmanship and satisfactory in its execution. But the blades of these saws are of too small diameter to frequently be of service to the surgeon, and the engines and gearing which drive them are not built of sufficient strength to admit of the employment of larger saws. In concluding the adduction of objections to the circular saw it is necessary to state that surgeons have always experienced great difficulty in protecting the soft parts while using it.

From what has been said it will be seen that in order to produce an osteotome of superior excellence to any we now have, it must be capable of dividing any bone in the human body, from the smallest to the largest, such division to be rapid, smooth, and certain, even though it be of the hardest bone; the blade of the instrument should readily follow the direction given it by the surgeon; it should be adapted to

simple, cuneiform, and longitudinal osteotomies in any situation, of easy manipulation and imparting to the hand of the surgeon all the sensations that could be appreciated with a probe ; possessing strength and portability, and not likely to get out of order ; and, finally, capable of being used without danger to the soft parts.

Such an instrument is illustrated in Fig. 1, from a photograph. It is here represented as it appears when suspended

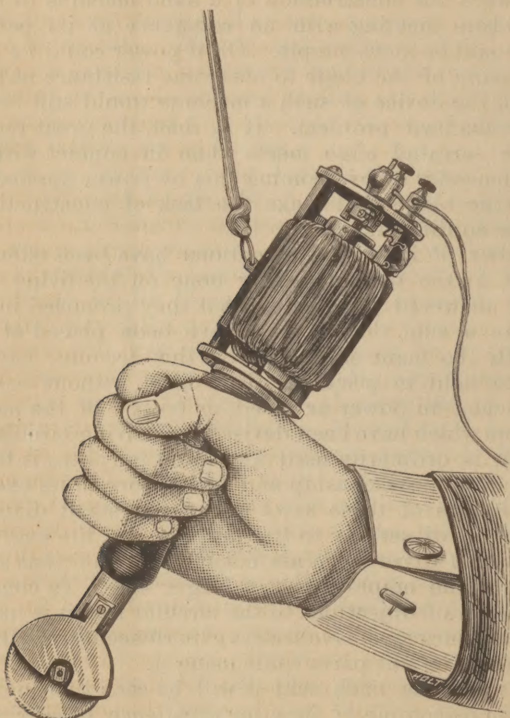

FIG. 1.

and grasped by the hand of the surgeon ready for action. It consists of a small electro-motor actuated, through insulated wires, by a powerful battery and carrying a circular saw that revolves in a plane parallel with that of the central shaft. A

hollow cylinder with a collar-like base is firmly screwed to the end plate of the motor and forms the handle of the instrument. Upon this a soft-rubber hand-piece, fashioned like that of a carpenter's chisel, is slipped and fastened in position; an arrangement which adds security to the surgeon's grip when operating. The central shaft of the motor is continuous through the hollow hand-piece. At its distal end, a right-angle miter-gearing connects it with the saw-bearing pivot. A metallic shield guards the proximal aspect of the serrated blade. Shields are provided for each size of saw. The depth of cut which it is possible to make with a given saw of course depends upon the diameter of the blade, being a trifle less than the distance from the centre to the periphery. The direction of the kerf, however, can be so modified as to enable the operator to easily divide a bone having a greater diameter than half that of the saw he is using.

The saws which I now use have been constructed with great care in accordance with my directions. Prior to their adoption I made extended experiments with many forms and sizes of teeth and thicknesses of blade. In order to adapt the saw to the requirements of individual cases, I have thus far found it desirable to have four sizes, viz.: 32 (1¼ inch), 41 (1⅝ inch), 51 2 inches), and 63 (2½ inches) millimeters in diameter. The teeth are coarse in proportion to the size of the saw, and number 18, 16, 14, and 12, respectively, per linear inch (25 mm.). These saws are so ground as to gradually diminish in thickness from the periphery to the centre. Binding in the kerf, when making deep cuts, is thus prevented. If the blade be made of the same thickness throughout, the side friction will be so great that the motor will be unable to drive the saw with adequate force and speed after it has fairly entered the bone. Provision is still further made for increasing the width of the kerf over that of the saw by giving to the teeth a little "set." This latter procedure is a very delicate operation and requires considerable mechanical skill to do it properly. It is important that the alternate lateral inclination of the teeth should be perfectly regular throughout; otherwise, the smooth and easy cutting of the saw will be interfered with. In form, the serrations are slightly *raked* instead of *hooked*. They are so filed that their cutting edge is at a right angle with the blade, instead of being at an oblique angle, as in most circular saws. The blades are made of the best steel and have a special

spring temper. They are not so hard as those used in cutting iron or brass, nor are they so soft as those used in cutting wood. Saws tempered for metal work, are too brittle for sawing bone; they would be apt to snap in the kerf, should the operator permit any lateral deviation of the blade. Tempered for sawing timber, the teeth would soon become dull by contact with hard bone. Lastly, great pains is taken to have the blades of the saws absolutely free from "buckle" or twist. This is necessary in order that they shall run perfectly true and not bind in the kerf.

Upon the plate at the opposite end of the motor from that to which the hand-piece is attached are two binding-posts, which receive the ends of the electrodes connecting the instrument with the battery. Considerable experimenting was necessary in order to determine upon a form of battery having sufficient duration and power without unnecessary bulk. A general idea of the battery which I use can be gained from Fig. 2. It is a *zinc carbon* battery. The cells are of glass and ten in number. Their dimensions are 2 x 7 x 8 inches. Each cell contains one zinc plate 6 x 8 inches, placed between two carbon plates of equal size. The fluid used is a solution of bichromate of potassium, known as red acid, somewhat stronger than that used in the ordinary faradic batteries. The duration of maximum power furnished by this battery is from twenty to twenty-five minutes, sufficient time for the performance of any number of osteotomies which the surgeon will ever be called upon to do at one sitting. The battery is only permitted to be in action during the brief periods required for making sections of bone. The zinc and carbon plates are firmly fastened to a board which is suspended above the glass cells by means of coiled springs, as shown in the cut. A lever at the side of the battery-box furnishes the means of submerging the plates in the fluid at pleasure, by simply depressing it. Upon releasing the lever the plates are automatically drawn out of the fluid by the action of the springs. Conservation of battery power is thus made perfectly feasible, for as soon as the surgeon has made a simple or cuneiform section of bone, the lever can be released and the further working of the battery prevented until he is again ready for action. In transportation the fluid is emptied from the cells. The framework which serves for the suspension of the plates is so constructed that it can be quickly taken apart and laid in the battery-box

on top of the board to which the plates are fastened. This arrangement makes the battery very compact and readily transportable.

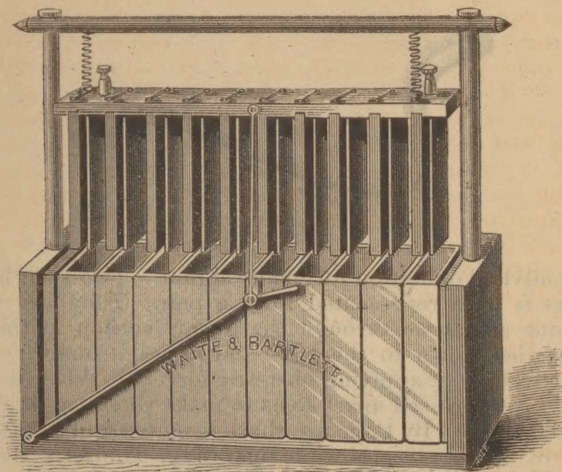

Fig. 2.

When using the electro-osteotome, it is suspended by a solid rubber cord, six or seven millimeters in diameter, from the cross-bar of an adjustable crane screwed to the edge of the operating-table. In this way all weight is removed from the hand of the surgeon, and leaves the instrument as thoroughly at his command as would be the most delicate probe.

The high rate of speed (about six thousand revolutions per minute) and the great force with which the saw is driven, necessitates skillful manipulation and great vigilance on the part of the operator in using the osteotome. The limb of the patient should be firmly held by an assistant, and the precise direction and extent of the cut determined upon before permitting the first impact of the blade against the bone. The keen eye and sense of touch of a skillful surgeon will readily appreciate whether there is any departure from the predetermined line of incision, or binding of the blade in the kerf.

And now as to the means of protecting the soft parts. Fig. 3 represents one form of protecting retractor, which I use in osteotomy operations. It was made for me by Messrs. Stohlmann, Pfarre & Co., and its form is specially adapted to the

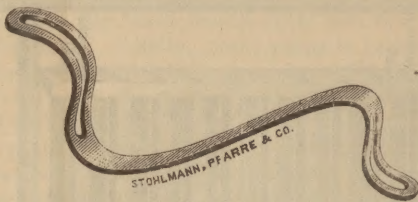

Fig. 3.

supracondyloid operation for genu valgum. Two such instruments as is here represented form a pair. They are introduced one at a time through the linear incision in the soft parts, carried down to the bone and passed around it, much after the fashion of applying obstetric forceps. When in position they are pressed apart so as to make room for the blade of the osteotome. By their use there is no possibility of injuring any of the soft tissues while operating. The retractors are provided with a double curve at each end, one large, the other small, so as to adapt them to large and small bones

In conclusion I may say, in illustration of the labor and time saving qualities of the electro-osteotome, that in operating for double knock-knee and bow-legs, I have removed wedges of bone in from thirty seconds to one minute that would require from fifteen to thirty minutes to chisel out. The incision made with the saw is clean, the severed ends of the bone are not comminuted, and the two cut surfaces can be readily and perfectly coaptated.

The mechanical details connected with the perfection of the instruments and battery above described have been very numerous, vexatious and at times discouraging. In prosecuting this work I have been the recipient of many courtesies at the hands of Mr. Edward P. Suter, of the Electro-Dynamic Co., Messrs. Wait & Bartlet, and the Western Electric Co., all of this city.

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